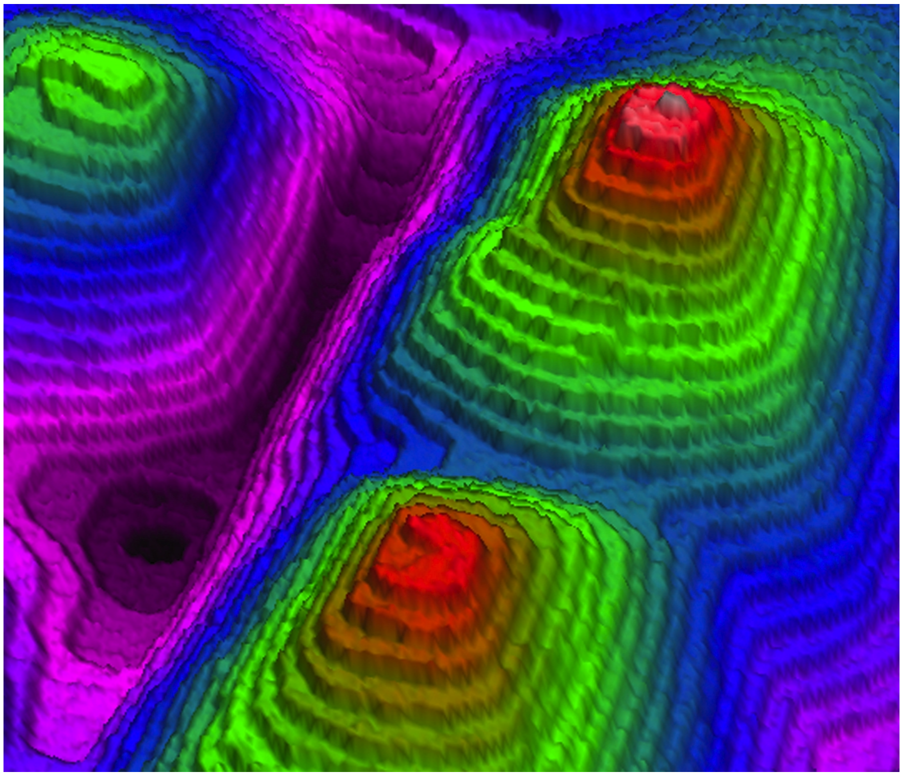
EPITAXIAL CRYSTAL GROWTH



STM image (about 1 µm across) of a GaSb film grown on GaAs(001) using MBE

Many recent advances in electronic and electro-optic device technology have been made possible by novel semiconductor film growth techniques, such as molecular beam epitaxy (MBE). These techniques permit layer-by-layer deposition of ultrapure crystalline thin films of selected semiconductors or metals, with resulting material properties that lead to enhanced device performance. The Naval Research Laboratory has a number of MBE systems, each configured for different classes of materials and with different electronic device goals, including a multidivisional Epicenter. This facility includes multiple, interconnected ultrahigh vacuum chambers for MBE film growth and film analysis. One growth chamber is dedicated to II-VI semiconductors and magnetic metals; the other to III-V semiconductors. Film growth in the II-VI/metal chamber is for the development of magnetoelectronic devices. In the other, alternating thin layers (superlattices) of the III-V compounds InAs and GaSb are grown. They show promise for use as infrared detectors. Film analysis is accomplished with angle-resolved electron spectroscopy and scanning tunneling microscopy (STM). These techniques provide information about elemental composition, bonding configurations, and morphology at a film surface. The figure shows a false-colored, three-dimensionally rendered STM image of the topography of a 4-µm-thick GaSb film grown on GaAs(001). Each “step” on the surface is about 0.3 nm high. The spiral-like mounds are associated with dislocations in the film caused by the relatively larger lattice of GaSb. Characterization of such films is aimed at optimizing film growth conditions to reduce dislocation density and, thereby, improve device performance.

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